Newton's Second Law for Rotation

Name: _____   Section: 2AL-____   Date performed: __/__/__

Lab station: ____   Partners: _____

Preliminary data

(Q-1) Measure the diameter of the drum with Venier calipers and calculate the drum radius.

$$2r = \text{\underline{\hspace{2cm}}} \qquad r = \text{\underline{\hspace{2cm}}}$$

(Q-2) Determine the lead angular distance (λ) and the angular distance over which the time is measured (θ), and calculate the numerator for the angular acceleration.

$$\lambda = \text{\underline{\hspace{2cm}}} \text{ rad} \qquad \theta = \text{\underline{\hspace{2cm}}} \text{ rad} \qquad 2(\sqrt{\lambda + \theta} - \sqrt{\lambda})^2 = \text{\underline{\hspace{2cm}}} \text{ rad}$$

Measuring rotational inertia using Newton's Second Law for rotation

(Q-3) Fill in the following table.

Hanging mass (kg)	Measured photogate times (s)					Average Δt (s)	Angular acceleration (rad/s^2)
	1	2	3	4	5		
0.050							
0.060							
0.070							
0.080							
0.090							
0.100							

How did you calculate the angular acceleration? Is this really any different from what you did in the Newton's Second Law (for translation) Lab?

(Q-4) Continue the analysis by completing the following table.

Hanging mass (kg)	Hanging weight (N)	Angular acceleration (rad/s²)	Tension (N)	Torque (N m)
0.050				
0.060				
0.070				
0.080				
0.090				
0.100				

(Q-5) Plot torque vs. angular acceleration and determine the experimental value of the rotational inertia of the disk wheel.
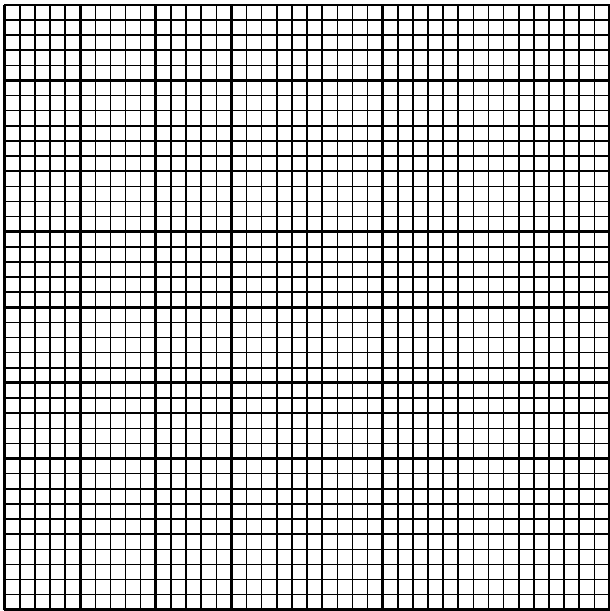
$I_{\text{exp}} = $ _____ $\pm$ _____   Friction torque = _____

Explain how these two quantities are obtained from your graph.

Compare experimental rotational inertia with measured value

(Q-6) Record the mass of the disk and measure the diameter of the disk and use these values to calculate the rotational inertia of the disk by itself.

Disk mass = _____ ± _____   Disk diameter = _____ ± _____

$$I_{\text{disk}} = \underline{\hspace{2cm}} \pm \underline{\hspace{2cm}}$$

Account for the spider by adding $I_{\text{spider}} = 0.002 \, \text{kg} \, \text{m}^2$ to the rotational inertia of the disk.

$$I_{\text{disk+spider}} = \underline{\hspace{2cm}} \pm \underline{\hspace{2cm}}$$

(Q-7) Compare the two rotational inertias using the discrepancy test.

Do they agree? Explain.

Exercises

Suppose you were to increase λ without changing θ. How would you expect the photogate time to be affected?

    (A) The photogate time should decrease.
    (B) The photogate time should increase.
    (C) The photogate time should remain the same.
    (D) The answer depends on the specific values of λ and θ.

Explain:

Suppose that in the process of releasing the disk, you managed to give the disk a small push (therefore releasing it with non-zero initial angular velocity). How would you expect the photogate time to be affected?

    (A) The photogate time should decrease, regardless of whether the initial angular velocity is clockwise or counterclockwise.
    (B) The photogate time should increase, regardless of whether the initial angular velocity is clockwise or counterclockwise.
    (C) The photogate time should remain the same.
    (D) The answer depends on whether the disk is pushed clockwise or counterclockwise.

Explain:

If the lead angular distance λ were exactly zero, then the numerator of the angular acceleration, $2(\sqrt{\lambda + \theta} - \sqrt{\lambda})^2$, would reduce to 2θ, and the angular acceleration itself would be given by $\alpha = 2\theta/\Delta t^2$. Suppose instead that the lead angular distance were 1% of θ (i.e., $\lambda = 0.01\theta$). In this case, $2(\sqrt{\lambda + \theta} - \sqrt{\lambda})^2$ would equal

    (A) 1.99θ
    (B) 1.98θ
    (C) 1.96θ
    (D) 1.80θ
    (E) 1.64θ

Using you answer above, explain why we do not try to release the disk just in front of the photogate.

The angular acceleration of the disk between the time it is released and the time it triggers the photogate for the second time is
    (A) Zero.
    (B) Increasing.
    (C) Decreasing.
    (D) Constant.

After the disk has been released, the tension in the string is _____ the hanging weight.
    (A) equal to
    (B) less than
    (C) greater than
    (D) Not enough information given
Explain without equations:

Before the disk has been released (while it is being held fixed in place), the tension in the string is _____ the hanging weight.
    (A) equal to
    (B) less than
    (C) greater than
    (D) Not enough information given
Explain without equations:

Now that you have performed the lab and answered all the questions above, go back to the Newton's Second Law Lab and examine that lab, including the exercises. How would you compare the two labs? What does this tell you about the relationship between translational motion and rotational motion?